The Filoviruses

- **Family:** Filoviridae, at least 4 genera
  - **Genus:** Marburgvirus
    - **Species:** Marburg Marburgvirus;
      - 2 strains: Marburg (MARV) – ancestral location ? Uganda; RAVN (RAAV) [Ravn name of the Danish patient from whom first isolated] – ancestral location, ? Kenya
  - **Genus:** Dianlovirus
    - **Species:** Mengla virus ; Other species ?
    - Newly identified, China, phylogenetically between Ebola & Marburg viruses
    - Has potential to cause severe; actual disease-causing capability unknown
  - **Genus:** Cueva virus
    - **Species:** Lloviu cuevavirus (LLOV) – Spain; also France & Portugal
    - Pathogenic to bats; no human infections described
‘Superbugs’: Filoviruses
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Isolation of genetically diverse Marburg virus in Egyptian fruit bats  PLOS Aug 2009

Kibuku Cave Uganda

Virus hunter, Watsa DRC

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Marburg virus activity over time (1967 – 2017)

<table>
<thead>
<tr>
<th>Year</th>
<th>Virus</th>
<th>Geographic Location</th>
<th>Human Deaths</th>
<th>Cases</th>
<th>CFR</th>
</tr>
</thead>
<tbody>
<tr>
<td>1967</td>
<td>MARV</td>
<td>Marburg and Frankfurt, GERMANY</td>
<td>7</td>
<td>29</td>
<td>24%</td>
</tr>
<tr>
<td>1967</td>
<td>MARV</td>
<td>Belgrade, YUGOSLAVIA</td>
<td>0</td>
<td>2</td>
<td>0%</td>
</tr>
<tr>
<td>1975</td>
<td>MARV</td>
<td>Johannesburg, SOUTH AFRICA</td>
<td>1</td>
<td>3</td>
<td>33%</td>
</tr>
<tr>
<td>1980</td>
<td>MARV</td>
<td>Nairobi, KENYA</td>
<td>1</td>
<td>2</td>
<td>50%</td>
</tr>
<tr>
<td>1987</td>
<td>RAVV</td>
<td>Nairobi, KENYA</td>
<td>1</td>
<td>1</td>
<td>100%</td>
</tr>
<tr>
<td>1988</td>
<td>MARV</td>
<td>Koltsovo, RUSSIA</td>
<td>1</td>
<td>1</td>
<td>100%</td>
</tr>
<tr>
<td>1990</td>
<td>MARV</td>
<td>Koltsovo, RUSSIA</td>
<td>0</td>
<td>1</td>
<td>0%</td>
</tr>
<tr>
<td>1998-2000</td>
<td>MARV &amp; RAVV</td>
<td>Durba &amp; Watsa, DEMOCRATIC REPUBLIC OF CONGO</td>
<td>128</td>
<td>154</td>
<td>83%</td>
</tr>
<tr>
<td>2004-2005</td>
<td>MARV</td>
<td>Uige, ANGOLA</td>
<td>227</td>
<td>252</td>
<td>90%</td>
</tr>
<tr>
<td>2007</td>
<td>MARV &amp; RAVV</td>
<td>Kamwenge District, UGANDA</td>
<td>1</td>
<td>4</td>
<td>25%</td>
</tr>
<tr>
<td>2008</td>
<td>MARV</td>
<td>Colorado, USA</td>
<td>0</td>
<td>1</td>
<td>0%</td>
</tr>
<tr>
<td>2008</td>
<td>MARV</td>
<td>Lieden, NETHERLANDS</td>
<td>1</td>
<td>1</td>
<td>100%</td>
</tr>
<tr>
<td>2012</td>
<td>MARV</td>
<td>Kampala, Ibanda, Mbarara and Kabarole, UGANDA</td>
<td>9</td>
<td>18</td>
<td>50%</td>
</tr>
<tr>
<td>2014</td>
<td>MARV</td>
<td>Mpigi, UGANDA</td>
<td>1</td>
<td>1</td>
<td>100%</td>
</tr>
<tr>
<td>2017</td>
<td>MARV</td>
<td>Kween District, UGANDA</td>
<td>2</td>
<td>2</td>
<td>100%</td>
</tr>
</tbody>
</table>

Ref: wikipedia.org
# Ebola virus activity over time (1976 – 2001)

<table>
<thead>
<tr>
<th>Year</th>
<th>Virus</th>
<th>Geographic Location</th>
<th>Human Deaths</th>
<th>Cases</th>
<th>CFR</th>
</tr>
</thead>
<tbody>
<tr>
<td>1976</td>
<td>SUDV / EBOV</td>
<td>Porton Down, UNITED KINGDOM (laboratory accident)</td>
<td>0</td>
<td>1</td>
<td>0%</td>
</tr>
<tr>
<td>1976</td>
<td>SUDV</td>
<td>Juba, Maridi, Nzara and Tembura, SUDAN</td>
<td>151</td>
<td>284</td>
<td>53%</td>
</tr>
<tr>
<td>1976</td>
<td>EBOV</td>
<td>Yambuku, ZAIRE</td>
<td>280</td>
<td>318</td>
<td>88%</td>
</tr>
<tr>
<td>1977</td>
<td>EBOV</td>
<td>Bonduni, ZAIRE</td>
<td>1</td>
<td>1</td>
<td>100%</td>
</tr>
<tr>
<td>1979</td>
<td>SUDV</td>
<td>Nzara, SUDAN</td>
<td>22</td>
<td>34</td>
<td>65%</td>
</tr>
<tr>
<td>1994</td>
<td>TAFV</td>
<td>Tai National Park, CÔTE D’IVOIRE</td>
<td>0</td>
<td>1</td>
<td>0%</td>
</tr>
<tr>
<td>1994-1995</td>
<td>EBOV</td>
<td>Woleu-Ntem and Ogooué-Ivindo Provinces, GABON</td>
<td>31</td>
<td>52</td>
<td>60%</td>
</tr>
<tr>
<td>1995</td>
<td>EBOV</td>
<td>Johannesburg, SOUTH AFRICA</td>
<td>1</td>
<td>2</td>
<td>50%</td>
</tr>
<tr>
<td>1995</td>
<td>EBOV</td>
<td>Kikwit, ZAIRE</td>
<td>254</td>
<td>315</td>
<td>81%</td>
</tr>
<tr>
<td>1996</td>
<td>EBOV</td>
<td>Mayibout, GABON</td>
<td>21</td>
<td>37</td>
<td>57%</td>
</tr>
<tr>
<td>1996</td>
<td>EBOV</td>
<td>Sergiyev Posad, RUSSIA (laboratory accident)</td>
<td>1</td>
<td>1</td>
<td>100%</td>
</tr>
<tr>
<td>1996-1997</td>
<td>EBOV</td>
<td>Ogooué-Ivindo Province, GABON; Cuvette-Ouest Department, REPUBLIC OF THE CONGO</td>
<td>45</td>
<td>60</td>
<td>75%</td>
</tr>
<tr>
<td>2000-2001</td>
<td>SUDV</td>
<td>Gulu, Mbarara and Masindi Districts, UGANDA</td>
<td>224</td>
<td>425</td>
<td>53%</td>
</tr>
</tbody>
</table>

# Ebola virus activity over time (2001 – current)

<table>
<thead>
<tr>
<th>Year</th>
<th>Virus</th>
<th>Geographic Location</th>
<th>Human Deaths</th>
<th>Cases</th>
<th>CFR</th>
</tr>
</thead>
<tbody>
<tr>
<td>2001-2002</td>
<td>EBOV</td>
<td>Ogooué-Ivindo Province, GABON; Cuvette-Ouest Department, REPUBLIC OF THE CONGO</td>
<td>107</td>
<td>135</td>
<td>79%</td>
</tr>
<tr>
<td>2002</td>
<td>EBOV</td>
<td>Ogooué-Ivindo Province, GABON; Cuvette-Ouest Department, REPUBLIC OF THE CONGO</td>
<td>10</td>
<td>11</td>
<td>91%</td>
</tr>
<tr>
<td>2002-2003</td>
<td>EBOV</td>
<td>Cuvette-Ouest Department, REPUBLIC OF THE CONGO; Ogooué-Ivindo Province, GABON</td>
<td>128</td>
<td>143</td>
<td>90%</td>
</tr>
<tr>
<td>2003</td>
<td>EBOV</td>
<td>Cuvette-Ouest Department, REPUBLIC OF THE CONGO</td>
<td>29</td>
<td>35</td>
<td>83%</td>
</tr>
<tr>
<td>2004</td>
<td>EBOV</td>
<td>Koitsovo, RUSSIA (laboratory accident)</td>
<td>1</td>
<td>1</td>
<td>100%</td>
</tr>
<tr>
<td>2004</td>
<td>SUDV</td>
<td>Yambio County, SUDAN</td>
<td>7</td>
<td>17</td>
<td>41%</td>
</tr>
<tr>
<td>2007</td>
<td>EBOV</td>
<td>Kasai Occidental Province, DEMOCRATIC REPUBLIC OF THE CONGO</td>
<td>186</td>
<td>264</td>
<td>71%</td>
</tr>
<tr>
<td>2007-2008</td>
<td>BDBV</td>
<td>Bundibugyo District, UGANDA</td>
<td>37</td>
<td>149</td>
<td>25%</td>
</tr>
<tr>
<td>2008-2009</td>
<td>EBOV</td>
<td>Kasai Occidental Province, DEMOCRATIC REPUBLIC OF THE CONGO</td>
<td>14</td>
<td>32</td>
<td>45%</td>
</tr>
<tr>
<td>2012</td>
<td>SUDV</td>
<td>Kibaale District, WESTERN UGANDA</td>
<td>36</td>
<td>77</td>
<td>47%</td>
</tr>
<tr>
<td>2012</td>
<td>BDBV</td>
<td>Orientale Province, DEMOCRATIC REPUBLIC OF THE CONGO</td>
<td>34</td>
<td>62</td>
<td>54%</td>
</tr>
<tr>
<td>2013-2016</td>
<td>EBOV</td>
<td>Liberia, Sierra Leone, Guinea, Limited and local: Nigeria, Mali, United States, Senegal, Spain, United Kingdom, Italy</td>
<td>11, 310</td>
<td>28, 616</td>
<td>70-71 / 57-59 %</td>
</tr>
<tr>
<td>2014</td>
<td>EBOV</td>
<td>DRC</td>
<td>49</td>
<td>66</td>
<td>74%</td>
</tr>
<tr>
<td>2018</td>
<td>EBOV</td>
<td>DRC</td>
<td>33</td>
<td>54</td>
<td>61%</td>
</tr>
<tr>
<td>2018-present</td>
<td>EBOV</td>
<td>DRC</td>
<td>1277</td>
<td>2189</td>
<td>ongoing</td>
</tr>
</tbody>
</table>
Increasing frequency of recognized filovirus outbreaks in Africa since 1990

Possible reasons:

- Better surveillance and capability to rapidly diagnose and characterize filovirus infections
- Spread among wild non-human primates and other animals > human epidemics d/t hunting, slaughtering, butchering and human consumption of infected dead animals (food chain)
- Epidemiology and ecology is more complex than previously understood
- Animal-human spillover infections because of human encroachment on natural ecosystems
- Increased human exposure driven by legal and illegal financial incentives, particularly mining activities; tourism (Marburg)
- Proximity of outbreaks to larger cities and human movement > spread to other areas outside of the outbreak epicenter
Infection rates

- The number of people that one sick person will infect, on average and in the absence of an effective control intervention, is called $R_0$. For Ebola in 2 epidemics 1.3 – 1.8 (Chodwell, et al, J Theoretical Biology 2004;229:119-126)

<table>
<thead>
<tr>
<th>Infection Rate</th>
<th>Virus</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 &gt; 2</td>
<td>Hepatitis C, Ebola</td>
</tr>
<tr>
<td>1 &gt; 4</td>
<td>HIV, SARS</td>
</tr>
<tr>
<td>1 &gt; 10</td>
<td>Mumps</td>
</tr>
<tr>
<td>1 &gt; 18</td>
<td>Measles</td>
</tr>
</tbody>
</table>

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Filovirus transmission: what is known and what is not ...

- Limited data on how viral genomics affect phenotype/pathotype, patient VLs and epidemiological features of more recent filovirus strains

- Further study:
  - Role of aerosol (large droplets/small particles close to patients) transmission
  - Role on environmental contamination and fomite transmission
  - Degree to which minimally or mildly ill persons transmit infection
  - How long clinically relevant infection persists or persistence of Ebolavirus during convalescence
  - Role of ‘super-spreading events’ play in transmission dynamics
  - Whether strain differences or repeated serial passage in outbreak settings can impact virus transmission

‘Superbugs’: Filoviruses
Prof. Adriano Duse, University of the Witwatersrand, South Africa
A Webber Training Teleclass

The border ...
‘Superbugs’: Filoviruses
Prof. Adriano Duse, University of the Witwatersrand, South Africa
A Webber Training Teleclass

Public health impact far greater than case counts:

- Crippling of an already weakened health sector and HCW losses
- Significant impact on other endemic diseases (e.g. malaria) and associated mortality
- Substantial economic losses for entire sub-region
- Social disruption

Total number of cases and deaths:

- 8 May 2016: 28,616 cases; 11,310 deaths (overall case fatality: 40%) and > 10,000 survivors
- W African healthcare workers (HCW): 875 infections; 509 deaths, case fatality: 58% (in Sierra Leone: 72%)

DRC – North Kivu and Ituri provinces

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Ebola DRC – as at 21 May 2019

- Tenth EV outbreak in DRC; officially declared 1 August 2018
- 26 May 2019: 1920 cases; 1281 deaths (overall case fatality: 67%)
- Healthcare workers (HCW): 105 (6%); > 30 deaths
PPE for filovirus infections: a big challenge

Complexity of PPE
[2017: WHO Task Force on IPC, 1 Task Group looked at evidence for PPE]

- Differences in PPE items contained in packaged kits
- Discordant donning/doffing protocols; multiple steps (complexity)
- Regular training required
- Thermal discomfort and impaired mobility
- Scant evidence-based research regarding role of individual PPE items

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Obstacles to filoviral outbreak responses: the centrality of human behavior

DRC Battles

The world's second-biggest Ebola outbreak is still raging. Here's why.

Despite a coordinated response and a vaccine, the Democratic Republic of the Congo's struggle with the deadly virus seems to have no quick end in sight.

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Obstacles to the epidemic response

- Poor infection prevention and control practices, inadequate healthcare facility infrastructure, poor healthcare delivery
- Early outbreak population dynamics: initial mistrust and hostility towards multinational teams
- Filoviral infections attributed to witchcraft, zombification
- Denial of filovirus existence, a ploy of government to get international funds
- Anger; towards government and public health messages
- Behavioral, religious and cultural diversity
- Stigma of survivors, the infected or thought to be infected

Stigma

‘You are safe to your community...’

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Challenges inc. controversial public health messages

- ‘Do not eat bush game’
- Social distancing; no handshaking
- Closure of markets (economic implications) and recreational areas e.g. bars and discotheques
- Inequity regarding who gets vaccination / treatment
- Stopping of flights; border closures; travel bans
- Closure of mining operations (force majeur) - serious economic consequences for the W African sub-region
---

**Social media: the blame and misconceptions**

<table>
<thead>
<tr>
<th>America is going to release ebola in America and blame it on isis. New 9/11 and population control.</th>
</tr>
</thead>
<tbody>
<tr>
<td>This virus has the same symptoms with ZOMBIFICATION which was a voodoo practices; Zombie is defined as corpse said to be revived by witchcraft</td>
</tr>
<tr>
<td>Wow look at all this Bible prophecy coming true this tell me that it’s time for all of us to give our lives to JESUS right now and be covered by his blood we all need to repent of all our sins and ask JESUS to forgive us</td>
</tr>
<tr>
<td>Ebola is the lifeline for the American economy that has already tumbled over the edge. The virus can be more powerful than any bomb; especially if America holds the &quot;cure&quot;.</td>
</tr>
<tr>
<td>Our elites are particularly into genocide in Africa. You must not think that all white men wish to kill all black people. Its really all about oligarchs and elite Jew pigs.</td>
</tr>
<tr>
<td>I say drop a bomb on them they a third world country destroy their kings a boom we get Africa and we can sell it</td>
</tr>
<tr>
<td>Bull*** our government is spreading it to reduce the population. Remember satan has control over governments. Also our own government worships satan.</td>
</tr>
<tr>
<td>Americans have vaccine and probably they invent this virus during cald war and use on who else than poor africans !! but they dont give vaccine to anyone except of this 2 or 3 persons from USA few weeks ago who are healed while others (africans especially)you will be died !!</td>
</tr>
</tbody>
</table>

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**Social media: the blame and misconceptions**

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Social media: the blame and misconceptions

Catholic Archbishop: Ebola is punishment from God for homosexuality

Gays are under attack in Liberia after many Christian leaders, including Catholic Archbishop Lewis Zeigler of Monrovia, declared Ebola to be a punishment from God for the act of homosexuality.
‘Superbugs’: Filoviruses
Prof. Adriano Duse, University of the Witwatersrand, South Africa
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Hostility and suspicion: stoning of healthcare teams and survivors

- Individual human behavior and movement
- Host susceptibility
- Filovirus

- Geo-climatic, geographical and ecological
- Socio-cultural
  - Traditional beliefs, Traditional healers and Witchdoctors,
  - Religion,
  - Burial practices
- Suspicion and misconceptions
- Political
- Low-socioeconomic

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Speaker: Dr. Shahnaz Armin, Shahid Beheshti University of Medical Sciences, Iran

July 25, 2019
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Speaker: Robert Garcia, Stony Brook University Medical Center, New York City

(Assess Teleclass)
BED BUG PREVENTION IN THE HEALTHCARE SETTING
Speaker: Dr. Marcia Anderson, Environmental Protection Agency, United States

August 15, 2019
HOW TO ENGAGE AND EDUCATE NURSES IN EVIDENCE-BASED PRACTICE
Speaker: Eileen J. Carter, Columbia University School of Nursing

August 22, 2019
MEASURES TO PREVENT AND CONTROL VRE: DO THEY REALLY MATTER?
Speaker: Dr. Hilary Humphreys, The Royal College of Surgeons in Ireland

(Assess Teleclass)
MEAT, MONKEYS, AND MOSQUITOES: A ONE HEALTH PERSPECTIVE ON EMERGING DISEASES
Speaker: Prof. Laura Kahn, Woodrow Wilson School of Public and International

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